



What Can Ecosystem Services Do For You? From Assessments to Decisions

...transform information into action

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EU policy has resulted in an expectation of ecosystem-based management of the environment from land to the open sea

| Recent or Emerging European Environmental Directives (a) | Environmental Focus of the Directive | | | | |
|--|--------------------------------------|------------|---------------|---------|----------------------------------|
| | Land | Freshwater | Estuaries (b) | Coastal | Open Sea |
| Habitats Directive | ✓ | ✓ | ✓ | ✓ | Applicable only in the UK |
| Water Framework Directive | - | ✓ | ✓ | ✓ | - |
| Integrated Coastal Zone Management Recommendation | - | - | ✓? (c) | ✓ | - |
| European Commission Marine Strategy | - | - | ✓? | ✓ | ✓ |
| Proposed Marine Framework Directive | - | - | ✓? | ✓? | ✓ |

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| Water Framework Directive | 2000 | ✓ | ✓ | ✓ | - |
| Integrated Coastal Zone Management Recommendation | 2002 | - | ✓? (c) | ✓ | - |
| European Commission Marine Strategy | 2002 | - | ✓? | ✓ | ✓ |
| Proposed Marine Framework Directive | 2010 | - | ✓? | ✓? | ✓ |

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| Proposed Marine Framework Directive | - | - | ✓? | ✓? | ✓ |

We proclaimed a brave new world, where ecosystems were at the centre, and where there would be integration across policies, environments, disciplines and scales

Due to historical concerns, chemical contamination still drives many decisions

- ❖ A focus on contaminants has made clean-up and removal, rather than ecological balance, the focus of much policy
- ❖ There has been the development of an “ecothocracy”* – a Garden of Eden concept
 - Nature is good
 - Man is an interloper
 - The goal of restoration should be “baseline conditions” – return to an intact state
- ❖ However, given that humans are here to stay, this is not feasible
- ❖ Nor is it consistent with ecological reality – ecosystems are complex, and change is inherent, necessary and often irreversible

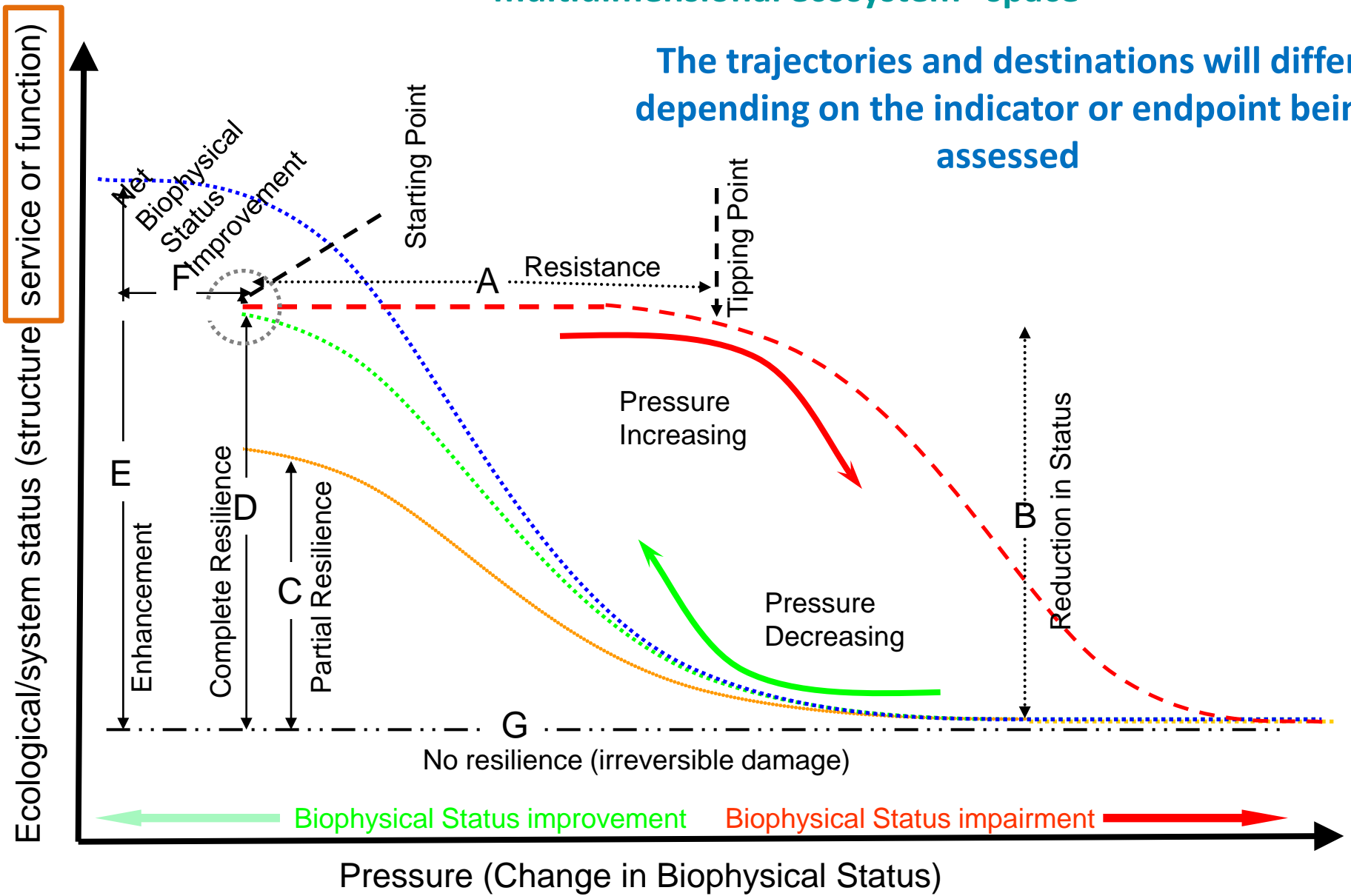
Ecosystems and “State”

- ❖ The concepts of climax communities assumes shifts between alternative stable states
 - Trees to grasslands, eelgrass to eutrophic
- ❖ However, communities respond to **environmental gradients**, have **memory**, and **change is inherent**
- ❖ Ecosystems are multidimensional and possibly unknowable
 - There can be multiple “stable” states
 - We can measure indicators of structure and function, but never fully define ecosystems
 - At best, we can decide what we value, and seek to manage that

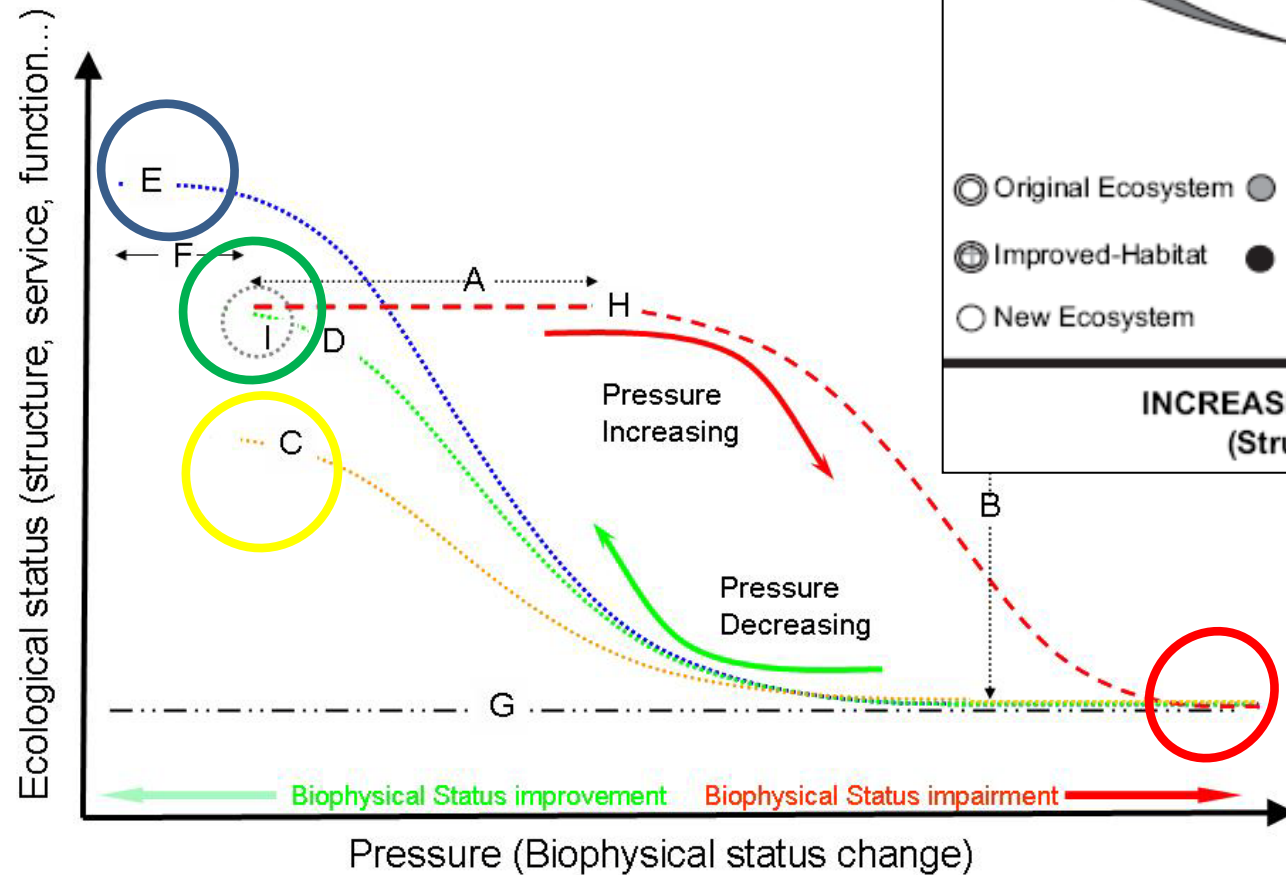
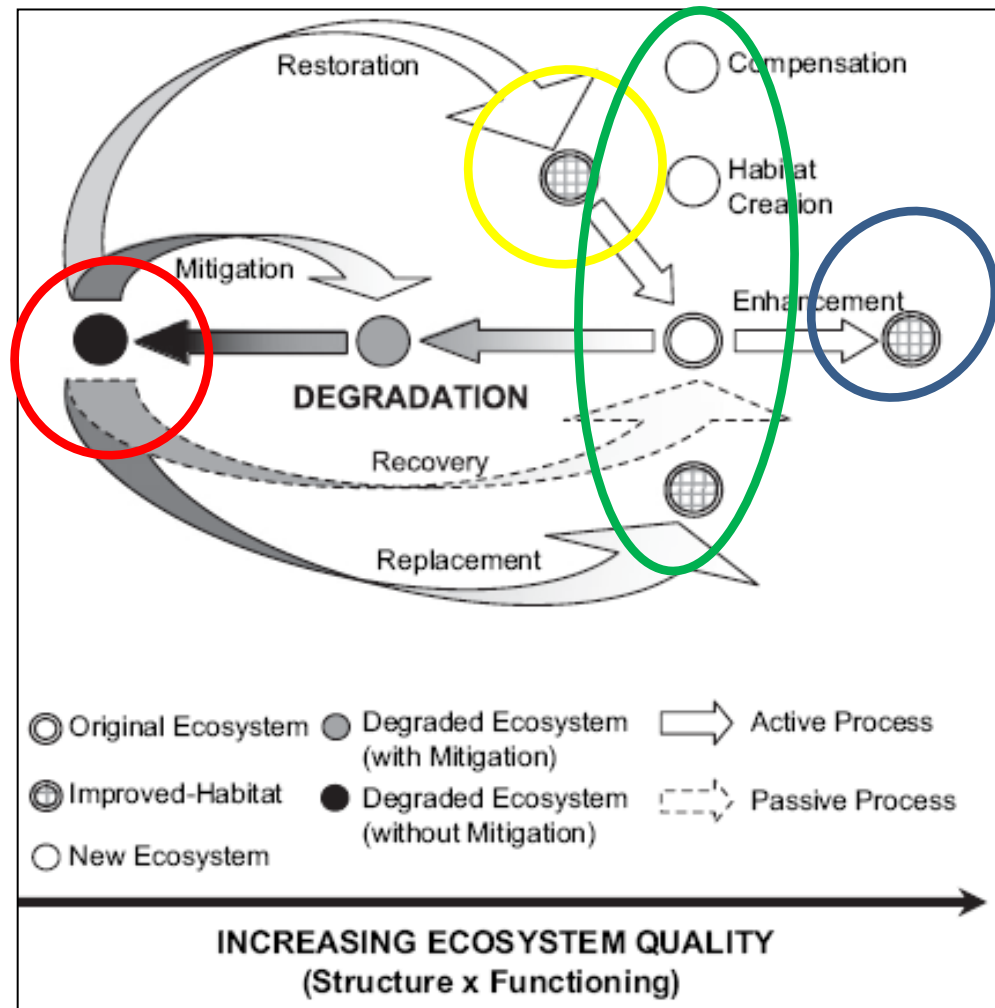
System response in put in ecological terms – this puts the measures in context

This is just a conceptual slice through a multidimensional ecosystem "space"

The trajectories and destinations will differ depending on the indicator or endpoint being assessed



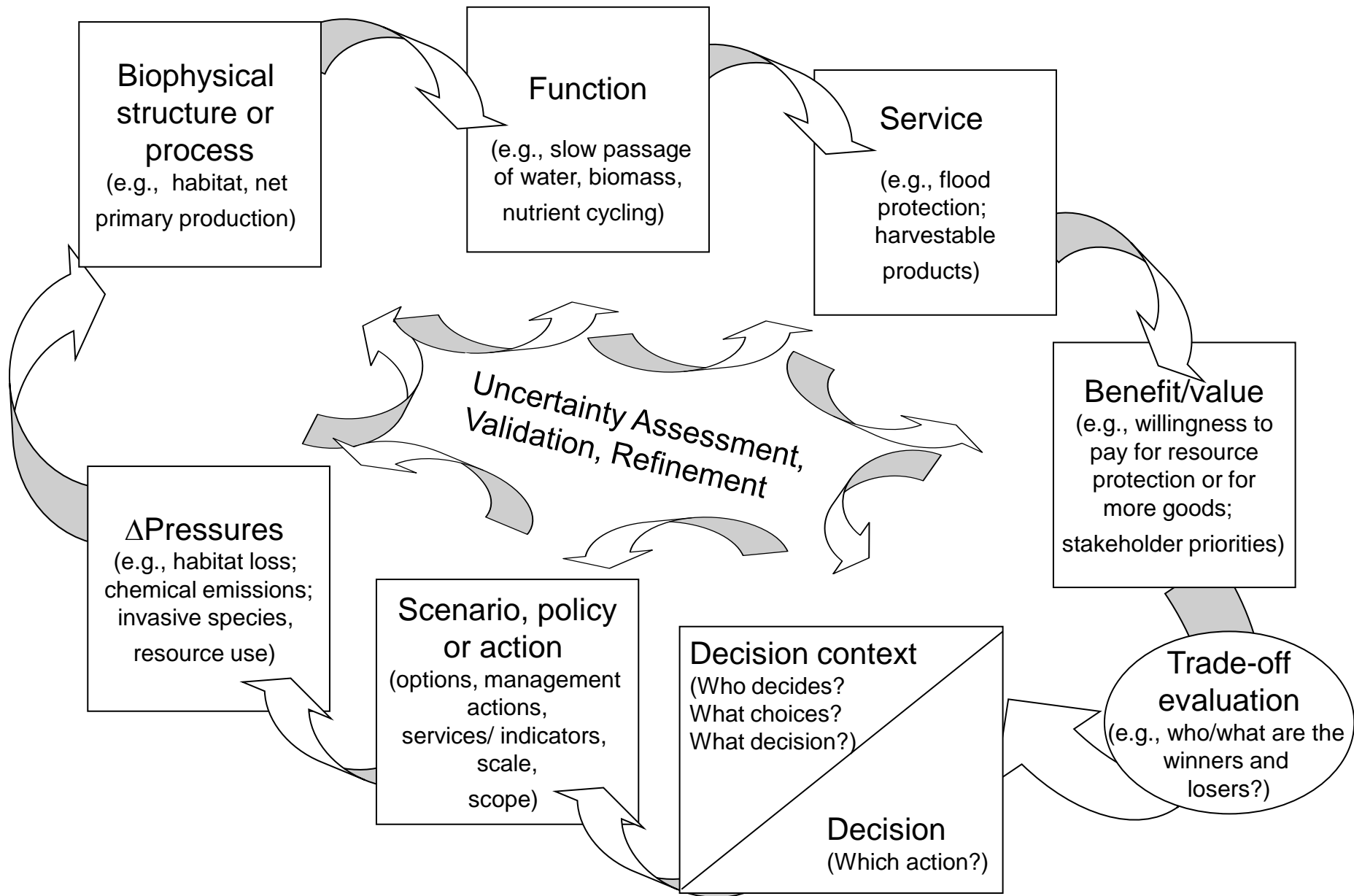
State, change, success and failure depend upon how we define starting points and what we are to measure
- Conceptual models must be clearly defined



WFD and Marine Strategy Directive Indicators of Ecosystem Health are Based Upon Community *Structure*

- ❖ In some systems, a focus on recovery of **structure alone** may guarantee failure
- ❖ “It is probable that the **diversity of function** is more important for the sustainability of ecosystem goods and services than species diversity per se...” Wall, 2004; SCOPE 64 (speaking on soils and sediments)
- ❖ There is a need to understand community ***functions***, *their response to pressures*, and *their relationships to ecosystem services*
- ❖ We need to ask: ***Even if changed, is this a functioning ecosystem?***

The Ecosystem Services (EsS) Decision Cascade

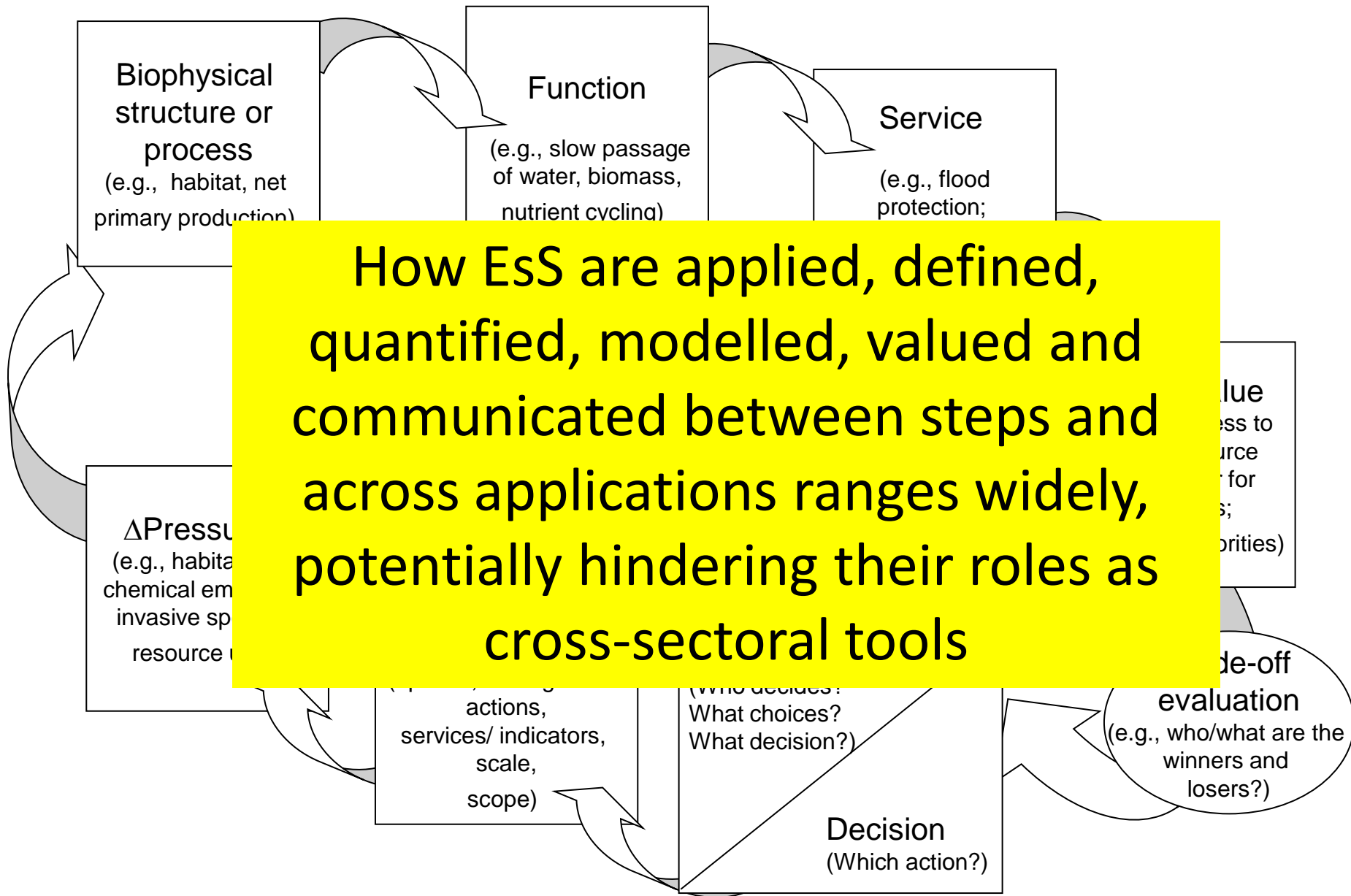


| Steps of EsS analysis | "Steps" or "levels" in the EsS Paradigm Cascade involved in analysis (From Figure 1) | | | | | | | | | |
|-----------------------|--|--------|--------------|-------------|------------|-----------|-----------|----------|----------------|------------|
| | Context | Policy | Requirements | Calibration | Assessment | Valuation | Trade-off | Decision | Implementation | Monitoring |

The cascade can be divided into decision analysis, assessment and valuation, leading again to decisions

| | | | | | | | | | | |
|-------------------|---|--|--|--|--|--|--|--|--|--|
| Decision analysis | Inform | | | | | | | | | |
| | Identifies scenarios, policies or actions that are to be evaluated | | | | | | | | | |
| | Follows valuation | | | | | | | | | |
| Assessment (EsA) | Is based upon specific current conditions or scenarios of change | | | | | | | | | |
| | Evaluates the links between biophysical structure, function and service provision | | | | | | | | | |
| Valuation (EsV) | Addresses human benefits and values of EsS in a decision-relevant context | | | | | | | | | |
| | Can be monetary or non-monetary | | | | | | | | | |
| | Identifies costs, benefits and trade-offs to inform decisions | | | | | | | | | |

The Ecosystem Services (EsS) Decision Cascade



Policy or action options for ecosystem management – how we address EsS should be driven by how “consumers” of the information may use it

| Policy or Action Options | Description | Examples |
|-------------------------------------|---|--|
| Prescription | Regulations requiring landscape management actions, standards, etc.; mitigation or cleanup requirements | Environmental requirements for developers and farmers; environmental quality standards; NRDA/ELD (public) |
| Property rights | Privatization and allocation of resources; can be | |
| Penalties/ rates | Costs of ecosystem services; can be | taxes ; |
| Persuasion / Education and outreach | Voluntary actions; can be | land (Service); |
| Persuasion / Compliance | By stakeholders, to provide context for a risk assessment, argue a point, or to advocate a proposed action or development within a regulatory context | protection; fair trade and organic products EsS-based risk assessment at a contaminated site; Net Ecosystem Service Assessment for mitigation or remediation (private); EsS-based advocacy for standards, or approval |
| Payments:* | Subsidies or direct payment to compensate private landowners for actions which benefit the public but are not captured by regular markets; | Often called payments for ecosystem services (PES) can be use-restricting or asset-building* |
| *Use-restricting | Pay parties not to utilize resources (such as farm land or forest) | REDD, REDD+ (Reducing Emissions from Deforestation and Degradation) |
| *Asset-building | Pay property owners or users for more sustainable asset use | Catchment sensitive farming (UK) |

Public and private entities have different actions available to them; even government bodies have a range of statutory powers and drivers

Categories of EsS-Based Decisions – EsS may play a lead or a supporting role in decisions

| EsSD Category | Purpose | EsSD Sub-category | Uses for EsS |
|---------------|---|--------------------------|--|
| Decisive | Consideration of costs and benefits of decisions or policies | Trade-off | Used to optimize decisions by informing choices that balance preference criteria |
| | | | Used to provide basis for environmental cost-benefit analysis |
| | | | Used to open debate of EsS, negotiate and define |
| Technical | Is used to assess the economic and social impacts of the project, also to determine what will be decided | | Used to allocate |
| | | | Information needed either to estimate damages caused |
| | | | Used to determine costs to pay, fees and |
| Informative | Is not applied directly to decisions, but it used to contribute to discussions, modify points of view or communicate aspects of decisions | Advocacy | Used to encourage the uptake of EsS considerations in public choice |
| | | Justification/Evaluation | Used by stakeholders to promote a given course of action. |
| | | | Used to evaluate the rationality of a decision a priori. |
| | | Accounting | Used to test a decision a posteriori |
| | | | Used to inform decision makers or the public about the state of natural capital |

Assessment and valuation approaches should be driven by the specifics of the question at hand and the statutory and other issues driving the information “consumers”

There are a range of perspectives from which EsS can be assessed

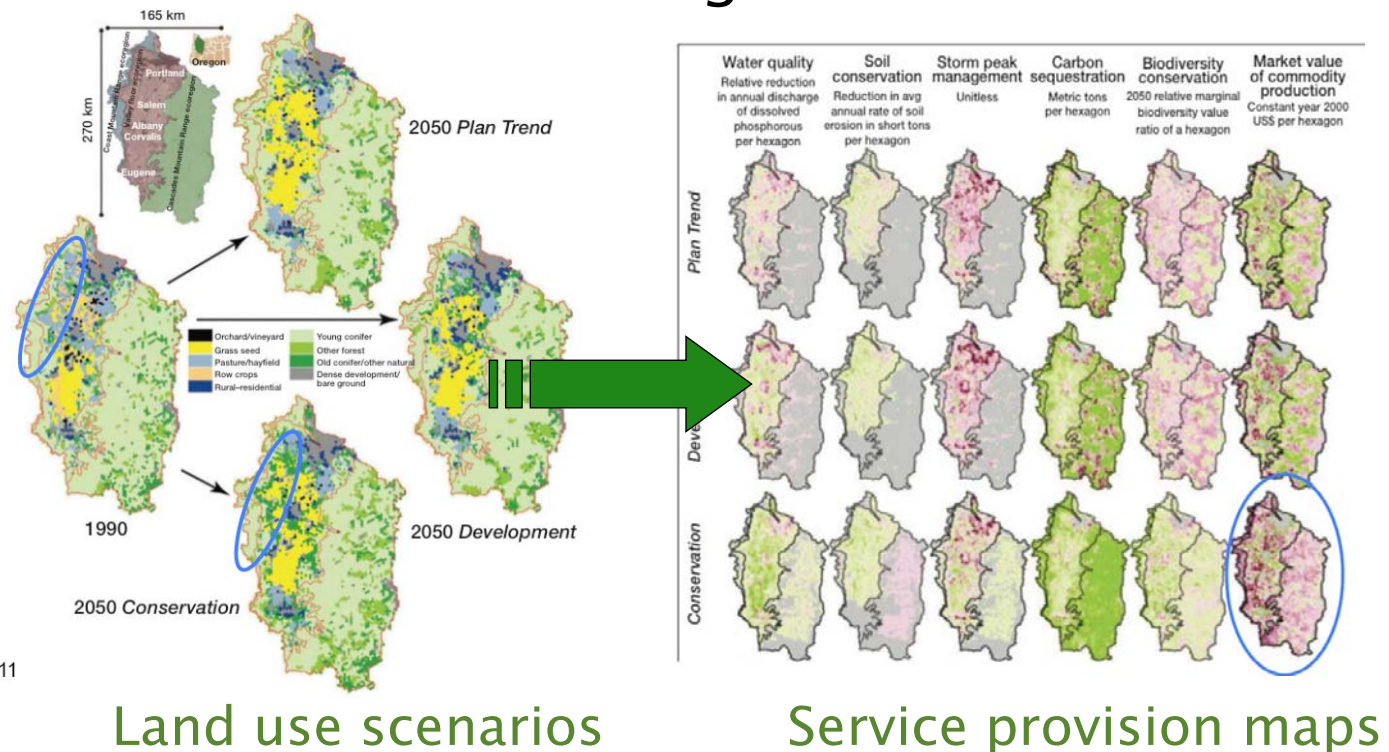
| Assessment Perspectives | Basis | Strengths | Limitations | Levels in Cascade | Top-down or bottom-up | Qualitative/ Quantitative |
|------------------------------------|--|--|--|---|-----------------------|----------------------------------|
| Habitats-based | - Treat habitats as SPU | - Good policy relevance | - Does not evaluate service cross-linkages | - Jumps from biophysical structure to service or value | Top-down | qualitative or semi-quantitative |
| | - Map habitat; extent equated with service provision | - Have been used to identify national scale conservation issues | - Assumes all benefits in proportion to habitat scale or type | - Assumes rather than evaluates function link | | |
| | - Focus on conservation or biodiversity status of habitat types | - Focus of many programs aimed at ecological assets | - Less effective at determining services other than biodiversity | - Major pressure evaluated is habitat loss | | |
| | | | - Does not evaluate service-specific responses to management | | | |
| Service-based | - Habitats provide biophysical conditions, but not focus | - Can frame an assessment of benefits of ecosystems | - Links or interactions between services may be unclear | - Jumps from biophysical structure to service or value | Top-down to bottom-up | qualitative or semi-quantitative |
| | - Service-by-service assessment | - Provides a qualitative basis for evaluating the effects of human action (adverse and beneficial) | - Does not allow multi-functional characteristics of ecosystems to be considered | - Assumes rather than evaluates function link | | |
| | - Service extent equated to presence of biophysical conditions | | - Does not consider the role of peoples needs and preferences | - Changes in pressures, if evaluated, are qualitative | | |
| Place- (or landscape)-based | - Focus on the dynamics of services associated with a particular place | - Allow for site-specific evaluation of service cross-linkages and effects of actions | - Generally more data intensive | - When qualitative, jump from biophysical structure to service or value | Bottom-up | qualitative - quantitative |
| | - Look at spatially-explicit interactions between habitat, land cover and management | - Can focus on services and outputs prioritized by stakeholders | | - When quantitative, can evaluate function-service link | | |

Types of EsS assessments

- Resource level assessment
 - ❖ Service- or habitat-based
- EsS-Based Ecosystem Response or Regional Assessment
 - Generally place- or landscape-based
- EsS-based Lifecycle Assessment
 - Still in development

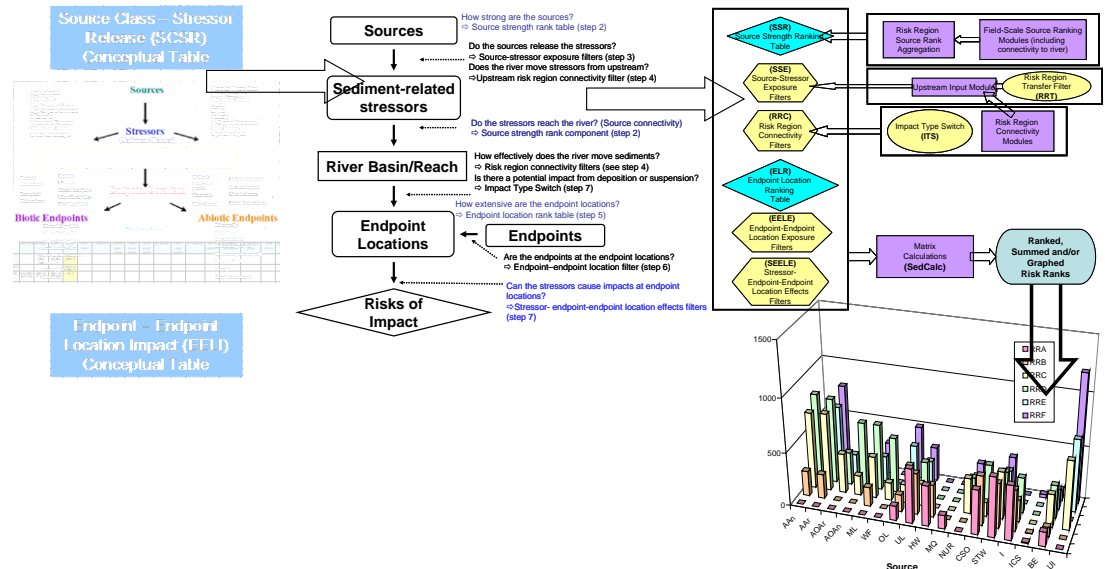
Resource level assessment – REsSA

- Map the extent or potentially trajectories of resource provision
- Identify baseline conditions and predict trajectories of recovery after restoration or remediation.
- Estimates of resource levels, rather than a mechanistic evaluation of what drives changes



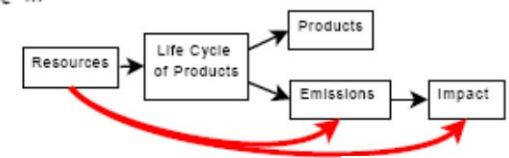
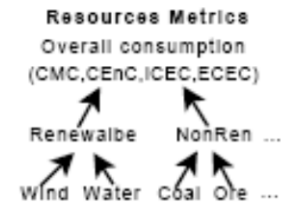
EsS-Based Ecosystem Response or Regional Assessment- EcoResA and EcoRegA

- Enhances or underlies traditional risk assessment by linking endpoints to EsS
- Assessment endpoints are linked to either biophysical process or function
- Can be simple or complex
- EcoRegA is spatially explicit and cross-scale
- Focus is on assessing pathways of effect
- Do not directly lead to valuation, but...
- Outputs can feed into valuations and comparative assessments

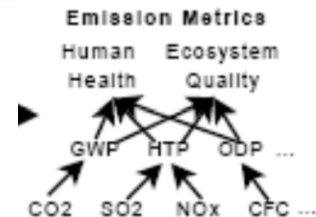


EsS-based Lifecycle Assessment – Eco-LCA

- Evaluates full scope of EsS effects (gains and losses) for all aspects of a proposed policy, product or development
- Quantitative assessment can be very complex
 - ❖ Current approaches do not address non-provisioning services due to lack of quantitative models



From Zhang 2008



EsS-based Lifecycle Assessment – Eco-LCA

- Evaluates full scope of EsS effects (gains and losses) for all aspects of a proposed policy, product or development
- Quantitative assessment can be very complex
 - ❖ Current approaches do not address non-provisioning services due to lack of quantitative models
- There is a scope for the development of more qualitative and semi-quantitative EcoLCA to help define impacts of proposals, policies, etc
 - ❖ Regional planning, strategic assessment, scoping for liability assessment

How the EsS Paradigm is Applied Depends on the Question at Hand

| EsSP Application Category | Purpose | Policy/Action options | EsSD category | Habitat, Service or Place-based | Potential Assessment Type | Regulatory driver |
|---|--|---|---|--|----------------------------------|--|
| National ecosystem and natural capital assessments | National, regional and global inventories of ecosystem services or capital | Persuasion / Education and Outreach | Informative/ Accounting; once developed, can play | H, S | REsSA | various |
| Local, regional or strategic planning | Evaluation of the environmental consequences of plans, policies, programs and projects | Various | Various | H, S, P | REsSA, EcoRA | SEA; EIA (EU) |
| Environmental and Social Impact Assessment | Evaluation of potential environmental and social impacts, including impacts to ecosystem services, from planned developments, to secure funding from lenders | Persuasion/ Compliance | Decisive; Informative/ Justification | H, S, P | REsSA, EcoRA, Eco-LCA | International Finance Corporation (IFC) Sustainability Framework |
| Environmental Damage | Determining the scale of measures to adequately offset legacy contamination, or threatened releases, endangering natural resources | Prescription (public); Persuasion/Compliance (private) | Technical/ Reference (public); Informative/ Justification | H, S, P | EcoRA | NRDA (US); ELD (EU) |
| Sustainable remediation/ disposal | Evaluation of trade-offs of alternative remediation options considering a range of scenarios, actions and changes so that EsS outcomes can be optimized | Persuasion/ Compliance (private) | Informative/ Justification (private) | S, P | EcoRA | various |
| Liability insurance | Environmental risk and liability review of facilities to identify and quantify possible insurance exposures due to potential environmental damage | Penalties/ rates | Technical/ Reference (private) | P | EcoRA | NRDA (US); ELD (EU) |
| Environmental security | Resilience planning to guard against human impact and environmental degradation from natural and man-made disasters | various | Technical/ Reference (public); Decisive | P | REsSA, EcoRA, Eco-LCA | various |
| Product Safety | Evaluation of EsS impacts of product manufacturing or use for licensing | Prescription (public); Persuasion / Education and Outreach (public) or Compliance (private) | Decisive / Tradeoff (public); Informative / Justification (private) | H, S, P | EcoRA, Eco-LCA | REACH; TSCA; EFSA; others |

Uncertainty and complexity

- EsS frameworks evaluate potential impacts in complex systems
 - ❖ Such systems are highly variable and interactions are uncertain
 - ❖ No model is more accurate than its least certain parameter
- However, ignoring parameters for which we don't have firm data doesn't make them go away
- Thus, EsS frameworks should only be as complex as they need to be, but broad enough to be relevant
 - ❖ Based upon the context of the decision, and the uncertainty of processes
- Uncertainty and variability can be addressed various ways
 - ❖ Precautionary approaches (worst case), probability, likely ranges, plausible scenarios, Bayesian approaches
- Adaptive management and decision-making addresses the reality of an uncertain world
- This is important to avoid or respond to unintended consequences

Concerns about EsS assessments

- The majority of studies consider 5 or fewer EsS*
 - ❖ Almost a quarter consider only one*
- More than 50% of studies considered EsS in isolation, without considering feedback or interactions between services*
- There is a lack of clarity, consistency, breadth and integration in a majority of EsS applications*
- Assumptions and models behind valuations are often not explicit†

*Seppelt et al (2011)

†Stahl et al (2003)

The Ecosystem Approach – cross-sectoral tool or greenwashing?

- Whether explicitly addressed or not, all management and policy choices result in EsS trade-offs
- EsS can provide a thread by which cross-sectoral decisions can be informed
- If policy and market changes are to support sustainability, then it is essential that we understand how actions will affect a range of EsS in space and time
 - But we should be aware of the limits of our knowledge
- EsS research, models and tools should help government and stakeholders make more informed decisions
 - This requires clarity, transparency and relevance of approaches

How do we better manage ecosystems?

- ❖ Be connected
 - Ecosystems are
- ❖ Be skeptical and transparent
 - The devil is in the details
- ❖ Be uncertain
 - The myth of certainty undermines credibility
- ❖ Be promiscuous
 - Use the best tools for the question at hand
- ❖ Be humble
 - Even simple systems have the capacity to surprise us
- ❖ Be adaptive
 - Monitor, adapt, respond and communicate

Thank you for your time

- ❖ I am grateful to many collaborators and colleagues, too numerous to list here (I've tried to credit images and ideas in slides)
- ❖ For more information, drsea@cvrl.org, or:
 - S E Apitz (2013) Ecosystem services and environmental decision making: Seeking order in complexity, *SESSS Special Issue, Integrated Environmental Assessment and Management* 9(2):414-430.
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